SUBMISSION TO THE ROYAL SOCIETY OF CANADA

COMMISION ON LEAD IN THE ENVIRONMENT

BY THE BELLEDUNE ENVIRONMENTAL MONITORING COMMITTEE

COMMITTEE MEMBERS

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BATHURST

INTRODUCTION

The Belledune Environmental Monitoring Committee is pleased to have this opportunity to present information to the Royal Society of Canada Commission on Lead in the Environment. The Committee is a group composed of agencies involved in environmental monitoring in the Belledune area. The effluents and emissions of industries in the Belledune area are the focus of the extensive monitoring work carried out by member agencies. Belledune is situated in a sparsely populated area on the south shore of the Baie des Chaleurs about thirty five kilometers north of the City of Bathurst.

Industrial development in the Belledune area includes a lead smelter and fertilizer plant operated by Brunswick Mining and Smelting (BM&S). The Belledune Environmental Monitoring Committee was formed in 1982 following an Environmental Impact Assessment study of the electrolytic zinc reduction plant proposed for the Belledune area. Although it appears that the zinc smelter may not be constructed in the near future, the Committee has carried out its objectives relative to the existing industrial operations.

The Committee's objectives are to:

- exchange and distribute environmental monitoring results including health study information from the Belledune area among the Committee members;

- encourage coordination of monitoring activities;

- provide a coordinating role to requests from the public for information related to monitoring activities and results; and,

- make recommendations to the New Brunswick Minister of Municipal Affairs and Environment and/or to relevant agencies concerning environmental monitoring.

The attached report outlines the monitoring data available and refers to particular interests of the Committee. Areas affected by elevated levels of heavy metals are identified, although interpretation of the actual impacts of these concentrations have not been attempted.

Since 1982 when the Committee was formed, it has highlighted areas of particular interest including:

a) completion of the health study begun in 1981

b) continuation of soil sampling

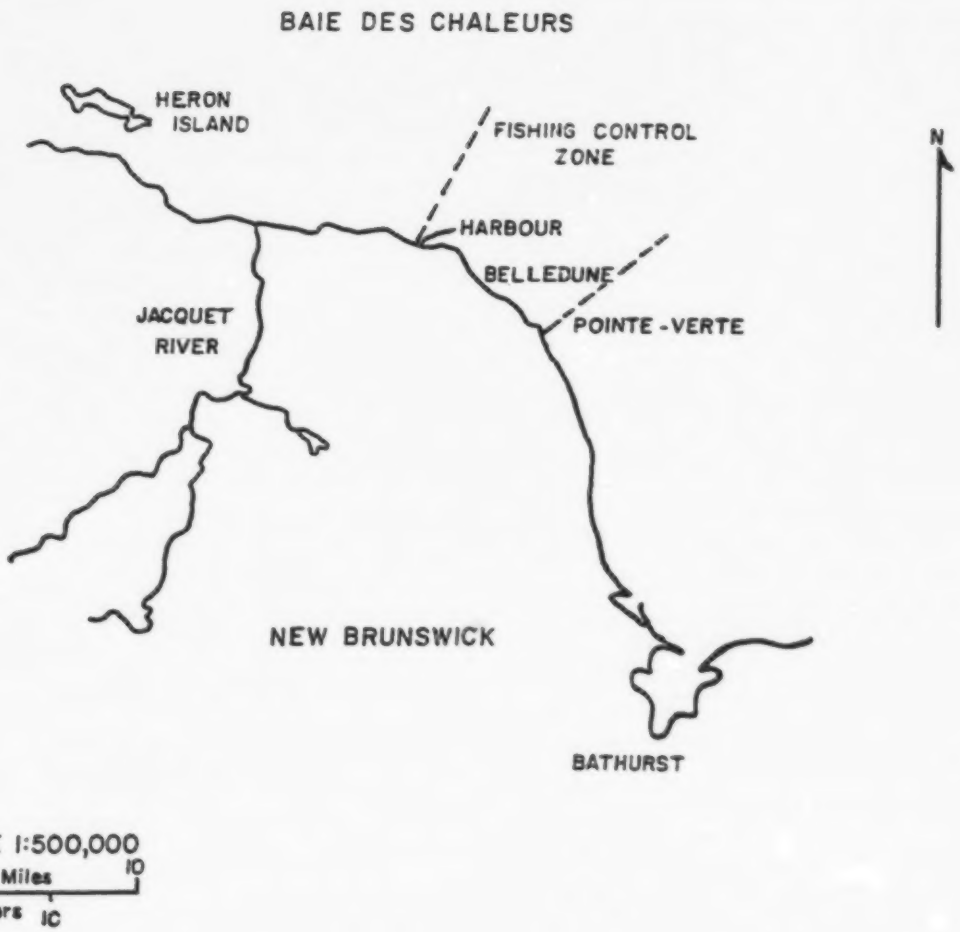
c) human health implications of elevated levels of heavy metals in lobster and other shellfish from the Baie des Chaleurs

d) investigation of concentrate dust escaping from railcars

e) auditing of SO2 monitoring equipment, and

f) heavy metals levels, particularly lead and arsenic in garden vegetables near the smelter; heavy metals loading in air emissions.

FIGURE 1 MAP OF THE BELLEDUNE AREA



1.0 SUMMARY OF ENVIRONMENTAL MONITORING

Highlights

From 1965 to the present, a variety of environmental monitoring has been carried out in the Belledune area. Both industry and government have been involved in these monitoring programs. Findings of the monitoring work are highlighted in Section 1.0. The monitoring work and results are described in more detail in the following sections of this submission.

Heavy metals contamination of the marine environment in the Belledune area has been of foremost concern. Before 1980 and the installation of a wastewater treatment plant at the lead smelter, monitoring results showed a trend of increasing metals contamination in sediment and certain marine organisms. The levels of cadmium detected in lobster near the smelter raised concern for public health.

A fishing closure zone banning lobster harvest in Belledune Harbour was enforced from 1980 to 1985. A control zone surrounding the closed harbour was also established. Lobster harvested in the control zone were required to be specially processed in order to remove the most contaminated tissues. Since 1980, the metals levels in lobster and other species of shellfish have begun to decrease in the harbour area. In 1985, with evidence of significantly reduced levels in lobster, the closure was lifted. The harbour was opened to fishing provided that the lobster were specially processed.

A recent DFO study of clams, mussels and scallops has indicated broad and nonspecific heavy metals contamination of shellfish in the Baie des Chaleurs. Further studies by DFO indicate that scallops in the vicinity of Belledune have much lower cadmium levels than scallops from Brown's Bank off of Newfoundland, an area far removed from known sources of cadmium contamination. Human exposure to heavy metals in shellfish has been reduced somewhat because most of the clam harvesting areas have already been closed due to bacterial contamination.

At present, air emissions contribute significantly more metals loading to the environment than the liquid effluent of the smelter. Air emissions contribute 90,000 kg lead/yr, and liquid effluent approximately 250 kg lead/yr. One baghouse was installed in 1971, and another in 1978, to help control particulates. The air emissions from the smelter caused significant elevations in metal levels in soil, vegetables, and forage in early years prior to 1978 in an area of approximately two kilometers radius from the smelter and fertilizer plant. In particular, lead levels in garden vegetables and arsenic levels in forage have been significant. However, no adverse effects of this metals accumulation have been documented. During weekly start up of the smelter acid plant and under certain meteorological conditions, SO_2 emissions from the smelter are occasionally above acceptable limits.

A more localized problem has been identified in the metals accumulation along the railway route for transporting concentrate from the Brunswick Mine to Belledune and Dalhousie. BM&S is researching techniques for dust containment. Since 1984, a dust suppressant has been applied to help control this dust problem.

In 1981, the New Brunswick Department of Health began a study, in cooperation with BM&S, to determine levels of lead and cadmium accumulating in humans, well water and potatoes from the Belledune area. Difficulties were encountered in completing analysis of these samples. Sampling was repeated in 1985 in order to reinstate this study, and results are expected to be available before May 1986.

Jacquet River, the source of water for the smelter and the Company's townships, is under study by DFO and BM&S. The river was also proposed as the source of water for the planned zinc smelter. DFO is concerned that due to water withdrawals the river flow may not be sufficient to maintain the habitats and populations of salmon and other fish species. BM&S has made efforts to reduce its water use and DFO has completed further studies of the river system. Negotiations between DFO and BM&S continue.

Monitoring of the fertilizer plant has indicated that, in relation to the smelter, its air emissions and liquid effluents are of less concern with repect to metals levels. The fertilizer plant is planning to modify its operations during 1986, and the impacts of the modifications are currently being assessed.

Considerable improvements in effluent treatment and some control of particulate air emissions have been achieved at the smelter. A number of environmental problems remain, but, given the continued active monitoring and involvement of government and industry, the outlook for environmental quality in the Belledune is encouraging.

2.0 ATMOSPHERIC EMISSIONS

SO_2 Emissions

SO_2 levels are monitored at three stations about 1.0 - 1.5 kilometers from the BM&S lead smelter. The SO_2 data collected at these stations from November 1979 to November 1983 is considered unreliable due to problems detected in the monitoring system. Monitoring results from the stack at the smelter's acid plant, however, indicate that exceedance of SO_2 limits has occurred occassionally. These exceedances are attributed mainly to start up of the acid plant. The problem with the three monitoring stations has been corrected and more frequent auditing of the system by the Department of Municipal Affairs and Environment is being carried out.

Particulate Emissions

Dust fallout, lead in dust, and sulfation levels are monitored regularly at the above-mentioned stations. In 1985, new sampling equipment (HiVol Samplers) was installed. It is expected to yield more exact information about suspended particulate than the dust bucket samplers used previously. Heavy metals and SO_2 are also measured at the smelter stacks. Stack monitoring in 1984 indicated the following emissions: 59,000 kg/yr lead, 2957 kg/yr cadmium, 5582 kg/yr arsenic, and 10,562 metric tonnes/yr SO_2.

Other monitoring related to atmospheric emissions includes soil, vegetable, forage, lichen and moss sampling. The largest proportion of cadmium loading to the environment from the smelter is discharged in air emissions.

2.1 ENVIRONMENTAL MONITORING OF AIR EMISSIONS

Soil

BM&S monitors heavy metals levels in soil near the smelter, and, as part of a multi-purpose soils study, the New Brunswick Department of Agriculture has sampled in an area further from the smelter.

Elevated levels of lead are found up to 1.8 kilometers from the smelter; cadmium (1.1 km), zinc (1.4 km), and copper (0.5 km).

Vegetables and Forage

BM&S monitors the levels of heavy metals in garden vegetables (potatoes, lettuce, beans, cabbage, beets) and forage in the area of the lead smelter.

In the 1980 Environmental Impact Assesment of the proposed zinc smelter, levels of cadmium, arsenic, zinc and especially lead were reported elevated in the immediate area of the plant. Lead levels exceeded the limits established in the Canadian Food and Drug Regulations governing heavy metals content in fresh vegetables. Arsenic levels for 1973 - 1979 appeared to be increasing; however, data from 1980 and 1981 indicate that arsenic values had returned to pre-1977 levels.

Difficulty in interpreting vegetation results may be attributed to variables associated with background interference and sampling technique.

Heavy metals levels in forage increase with nearness to the smelter. Generally, metals levels in forage are not considered "excessive" outside a 3 kilometer radius of the source.

Mosses and Lichens

The Belledune Regional Bioindicator Study was begun in 1980 for the purpose of determining the deposition patterns and loadings of several trace metals, in including lead, to vegetation in the vicinity of the lead smelter at Belledune.

Lichens collected within 31 km of the lead smelter in 1982 showed lead values ranging from 19.1 to 101.0 ppm, with a mean of 49.9 ppm, substantially elevated with respect to levels in rural New Brunswick. Elevated concentrations occurred at sites near to the smelter. There was also a significant negative correlation between lead concentration and distance from the smelter for the species Cladina stellaris. Enrichment factors for lead ranged from 368.3 to 2079.3

In moss bag air sampler deposition experiments in 1980 and 1981, lead deposition was significantly negatively correlated with distance from the smelter. Mean monthly deposition rates of lead were 0.11 and 0.25 $\mu g/cm^2$ for 1980 and 1981 respectively. The maximum monthly deposition recorded was 1.5 $\mu g/cm^2$.

In addition to emsissions from the lead smelter, possible sources of airborne lead in the Belledune area include windblown crustal materials from ore-rich soils and rock, and emissions from the transportation sector.

Metals Accumulation Along Railway

Since 1978 surveys have been conducted along the railway from the Brunswick # 12 Mine to Dalhousie to determine the extent of metals accumulation caused by concentrate dust escaping from rail cars. Two snow surveys have indicated that the dust fallout is heaviest within 32 meters (100 feet) on either side of the tracks.

Other surveys have included sampling well water and foliage near the tracks. The well water samples have indicated no contamination from railcar dusting. Trace metals were not elevated in the well water samples. Lead and zinc concentrations in white spruce needles collected near the tracks were frequently at or above values considered excessive for rural locations (50 ppm; Phytotoxicology: Excessive Levels for Contaminants - 1982, Ontario Ministry of the Environment). In April 1984, Brunswick Mining began using a dust suppressant to help control the railcar dusting problem.

3.0 LIQUID EFFLUENTS

Effluents

Before December 1980 and the installation of a waste water treatment plant, the smelter discharged its effluent to Belledune Harbour causing significant heavy metals contamination.

In December 1980, the smelter's discharge point for treated effluent was moved to a location outside the harbour. The treatment system has achieved a very significant reduction in the heavy metal loadings to the area, as shown in the following table (BM&S data).

TABLE 1 QUANTITIES OF CONTAMINANTS DISCHARGED BY THE SMELTER BEFORE AND AFTER THE NEW EFFLUENTS SYSTEM INSTALLED

	Old System (kg/day) (Untreated and discharged to harbour-before Dec/80)	New System(kg/day) (Treated and discharged outside harbour-Dec/80 to Dec/82	
Copper	1.9	0.05	97% reduction
Lead	23.8	0.72	97% reduction
Zinc	179.0	7.15	96% reduction
Cadmium	70.5	2.12	97% reduction
Arsenic	78.1	17.14	78% reduction
Suspended Solids	2440.0	8.80	98% reduction

Source: BM&S data (after Hildebrand, 1984)

BM&S is carrying out studies to improve the removal of arsenic in the smelter effluent.

In the fall of 1984, EPS carried out a special survey to measure radionuclides in the effluents from the fertilizer plant. The significance of the levels have not been interpreted.

3.1 ENVIRONMENTAL MONITORING OF LIQUID EFFLUENTS

Water and Sediment

The water and sediment of Belledune Harbour is heavily contaminated with cadmium and zinc. Metals concentrations decrease to background levels outside a 3 kilometer radius of the harbour. It is believed that the sediment contamination in the harbour has come about more as a result of spills or windblown concentrate from wharf facilities than from the smelter effluent alone. Most of the contaminated sediment is contained in the harbour. It should be noted that two mines (Anaconda and Nigadoo), which are no longer operating, shipped concentrates from Belledune Harbour.

Since the installation of the water management program and treatment plant in December 1980, the concentration of dissolved metals in the waters of the Belledune Harbour has decreased significantly.

In 1984, DFO conducted a study of the harbour water quality. It indicated a marked decrease in the levels of cadmium and zinc

relative to the levels recorded in 1980. Cadmium values had decreased 200-500 fold, and zinc values had decreased 10-100 fold. In 1984, metals levels in the inner harbour were 3-5 times that of background.

Mussels

Mussels native to the Belledune area have been found to have above-background levels of lead (up to 29 km from the smelter), cadmium (up to 24 km from the smelter), and zinc (up to 5 km from the smelter). The current in the Baie des Chaleurs has carried much of the contamination along the shore in a southeasterly direction Cadmium levels peaked in 1979, and appear to be decreasing since that time. Lead levels began decreasing in 1977.

Elevated levels of lead, zinc, and cadmium in mussels are correlated to levels in sediment. Bioaccumulation and decontamination studies have been conducted. At present, the following areas near Belledune are closed to shellfish harvesting due to bacterial contamiantion unrelated to the smelter: Belledune Harbour, Nigadoo River, Elmtree River, Millstream Gully and Bathurst Harbour. A recent DFO study of clams, mussels and scallops indicates a broad and nonspecific contamination of Baie des Chaleurs shellfish by heavy metals. Further studies by DFO indicate that scallops in the vicinity of Belledune have much lower cadmium levels than sacllops from Brown's Bank near Newfoundland, an area far removed from known sources of cadmium contamination.

Lobster

Lobster from the Belledune vicinity have been the subject of ongoing research by BM&S since 1975. Lobster growth and heavy metal concentrations in lobster were studied. Results indicated that tail and claw meat concentrations of heavy metals (Pb, Zn, and particularly Cd) were slightly elevated compared to background, and that there was an increase in metals levels over the period 1977 to 1979.

Further analysis in the fall of 1979 showed elevated levels of cadmium in the tomalley of the lobster. Based upon these results DFO, in collaboration with National Health and Welfare, considered the levels unacceptable for human consumption. Lobster fishing in the Belledune Harbour was curtailed, and a control zone established as shown in Figure 1. Lobsters harvested in this control zone required special processing.

As a result of the reductions in metals concentrations in the smelter effluent, metal levels in lobster have decreased. In early 1985, DFO and Health and Welfare Canada reviewed the information regarding heavy metal concentrations, and reopened the Harbour to lobster fishing by including the area as part of the control zone.

Other Marine Biota

Cadmium levels in marine biota from the area surrounding the harbour were examined. Background levels were found southeast of the harbour at distances greater than a few kilometers, and within 5 kilometers southeast of the harbour.

A general marine benthos survey is conducted every two years to determine species diversity in the harbour area. It is carried out by Beak Consultants for BM&S, and is used as an indicator of the quality of the marine environment.

4.0 HUMAN HEALTH

In 1981 samples were taken for a study by the federal and provincial Departments of Health. This study was initiated to determine cadmium levels in breast milk, lead and cadmium levels in well water, lead in human teeth and heavy metal levels in potatoes in the vicinity of the smelter and in a control area. Difficulties were encountered during the analysis of the samples taken for this study. The sampling was repeated during the fall of 1985. Results are expected before May 1986.

5.0 JACQUET RIVER MAINTENANCE FLOWS

During preparation of the Environmental Impact Assessment of the proposed zinc smelter, maintenance of adequate flows in the Jacquet River, the Company's source of water for the lead smelter and for the proposed zinc smelter, was highlighted as a concern. Since 1980, BM&S has reduced its water usage, and DFO has completed further studies of river flows and available salmon habitat.

TABLE 2 SUMMARY OF ENVIRONMENTAL MONITORING

Section	Type of Monitoring	Monitoring Agencies
2.0	Atmospheric Emissions	a,b
	SO_2 Emissions	
	Particulate Emissions	
	Dust Fallout	
	Sulfation Candles	
	HiVol Sampling	
2.1	Environmental Monitoring	
	Soil	a,c
	Vegetables and Forage	a
	Mosses and Lichens	b
	Metals Accumulation Along Railway	a,b
3.0	Liquid Effluents	a,b,d
	Effluents	
3.1	Environmental Monitoring	
	Water and Sediments	a,b,d,e
	Mussels	a,e
	Lobster	a,e
	Other Marine Biota	a,d,e
4.0	Human Health	a,f
5.0	Jacquet River Maintenance Flows	a,e

Monitoring Agencies

a) Brunswick Mining and Smelting (BM&S)
b) New Brunswick Department of Municipal Affairs and Environment (DMAE)
c) New Brunswick Department of Agriculture
d) Environmental Protection Service, Environment Canada (EPS)
e) Fisheries and Oceans Canada, Gulf Region (DFO)
f) New Brunswick Deparment of Health, and Health and Welfare Canada

TABLE 3 BACKGROUND

1965	Annual environmental monitoring began
1966	Lead/zinc smelting and refining began at Belledune
1968	Belledune Fertilizer Plant started operation
1971	Stress on organisms in the harbour first detected; Lead refinery baghouses were constructed to control fugitive air emissions
1972	Smelter modified to produce only lead, and sinter baghouse was installed
1978	Second major baghouse was installed
1979	Brunswick Smelting notified the New Brunswick Department of the Environment, and Fisheries and Oceans Canada of cadmium contamination in lobster
1980	Harbour closed to lobster fishing; control zone established; lobster in control zone required to have special processing
December 1980	Wastewater treatment facilities installed; Smelter outfall moved to a site outside the harbour
January 1981	Environmental Impact Assessment of proposed electrolytic zinc reduction plant completed; health study began
June 1982	Belledune Environmental Monitoring Committee formed
April 1985	Recommendations made to Minister of the New Brunswick Department of the Environment; Committee sent letter to DFO and NHW concerning heavy metal contamination of shellfish from the Baie des Chaleurs
August 1985	Health Study reinstated

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